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Fanciful Diagram of an Ancestral Circle Fan Chart With Ancestral Lines Vanishing Into The Distant Past.

## The DNA of Clan MacLeod

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### Abstract

The powerful MacLeod clan is thought to have originated in the Scottish Highlands in the 13<sup>th</sup> century. Twenty years ago, MacLeod clan members started Y-DNA testing to learn more about their origins. By analyzing the large dataset that has accumulated over these two decades, we found that most MacLeods in the MacLeod surname project at Family Tree DNA can be placed into one of five genetically distinct subgroups. MacLeods in the largest of these subgroups are proposed as the patrilineal descendants of the founder of the clan. Accordingly, the other four genetic subgroups comprise those whose distant ancestors became part of the clan and assumed the MacLeod surname.

The SNP BY3210 is common to all MacLeods in our proposed founder subgroup. The subsequent formation of two mutually exclusive descendant SNPs, FTT137 and FTT138, coincides with the traditionally established split of the chiefly line into two main groups: the Harris & Dunvegan and Lewis & Raasay branches. Several MacLeods with documented genealogies leading to these two chiefly lines carry SNPs consistent with this split. On a speculative basis, we have linked several other SNPs to early MacLeods in the chiefly lines. While there are some noted discrepancies, the estimated age of these SNPs fits with the history of Clan MacLeod.

Autosomal DNA results show that MacLeods crossmatch other MacLeods in all five Y-DNA genetic subgroups. This suggests that MacLeods who descended from the founder intermarried with MacLeods whose ancestors assumed the surname. Therefore, most MacLeods in the world today will have a link back to the founder – either along their paternal line or through a maternal connection in other parts of their family tree.

Four of the five genetic subgroups have origins in different parts of Scandinavia while the fifth subgroup has Celtic origins. The DNA evidence shows that the MacLeod clan was a melting pot of these diverse groups. Finally, Y-DNA evidence shows that the founder branch was likely in the Earldom of Orkney before arriving in Scotland. These Orcadian ancestors originated in Norway, consistent with the traditions of the clan.

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*Most of the main conclusions in this paper were presented at the 2023 MacLeod Clan Parliament on the Isle of Skye, Scotland (MacLeod and MacLeod, 2023).*

## Introduction

MacLeods across the world have long sought to understand their connection to the early MacLeod clan, given the clan's vivid and romantic history. Many MacLeods aspire to a lineage tied to one of the clan's two principal branches: the Harris & Dunvegan branch or the Lewis & Raasay branch. However, establishing a direct connection to the clan's historical records is challenging, primarily due to the scarcity of paper records prior to the late 18<sup>th</sup> century. Moreover, published MacLeod clan genealogies tend to focus on the immediate families of the clan chiefs, hindering attempts by modern-day MacLeods to trace their lineages back to these families. As a result, MacLeods are left wondering if there is a direct link between their MacLeod line and that of the presumed founder and progenitor of the clan, a man named Leòd, who is thought to have been born in the Common Era (CE) around 1215.

DNA testing provides a powerful independent tool to help establish these presumed connections, if they exist. Y-DNA testing follows the paternal line, on the premise that we may be able to establish a genetic signature and link to the origins of the clan if enough MacLeod men are tested. This study benefits from the fact that the MacLeod clan began about 800 years ago and there has been a long patrilineal succession of MacLeod clan chiefs. These chiefs usually had many offspring, and some of their claimed descendants are members of the MacLeod surname project, even if they are unaware of their chiefly connections. Moreover, we benefit from the active and interested MacLeod Clan Society members from around the world.

The MacLeod surname project at Family Tree DNA (FTDNA) was established by the Associated Clan MacLeod Societies (ACMS) in 2004, shortly after the first Y-DNA study of MacLeods was completed at University College London (Abernethy, 2004)<sup>1</sup>. This study found that men with the MacLeod surname, however spelled<sup>2</sup>, were genetically diverse, but that one of the larger genetically similar subgroups was most likely to represent the founding haplogroup of the clan. The author estimated that this subgroup emerged roughly 1000 years ago.

Later Y-DNA studies focused on defining the genetic attributes and possible origins of the founder branch (McLeod, 2005a, 2005b, 2006, 2008a, 2008b, and MacLeod and McLeod, 2013a, 2013b). Using STRs (short tandem repeats), high-level haplogroup designations and early SNP results, they also confirmed the genetic diversity of the clan.

McLeod (2018) also noted that the MacLeod clan was genetically diverse, drawing on SNP results from more advanced Y-DNA testing, including the then new Big Y test from FTDNA. He added that the largest subgroup of tested MacLeods carried the SNP R-BY3210 (hereafter BY3210), which likely represented the branch of the clan's founder. Furthermore, he noted that there were four sub-branches of the founder haplogroup BY3210 and predicted that more would be found as more MacLeods took Y-DNA tests.

<sup>1</sup>The Clan MacLeod website includes an article on the evolution and history of the MacLeod Y-DNA project and a Beginner's Guide to Y-DNA testing (<https://clanmacleod.org/genealogy/dna-project/>).

<sup>2</sup>The MacLeod surname has many spelling variants, including but not limited to McLeod, Macleod, McCloud, and McLoud. All spelling variants have been included in this study.

The results presented here expand on these prior studies. We delve deeper into the genetic diversity and distant origins of all the main subgroups of the clan, and we expand on the genetic genealogy of the founder branch and its two main branches – Harris & Dunvegan and Lewis & Raasay.

We also use autosomal DNA to investigate links between paternally unrelated subgroups of Clan MacLeod. Finally, we use Y-DNA results from descendants of men who came before the MacLeods to study the origins of the founder branch of MacLeod, the so-called chiefly line.

## Methods

### Administering the MacLeod surname project

Starting in 2004 when the MacLeod surname project was established at FTDNA, a succession of volunteer project administrators has:

- Interpreted members' Y-DNA haplogroup designations, SNPs, STRs, and Y-DNA match lists, all provided by FTDNA
- Created and continuously refined a MacLeod Y-DNA genetic subgrouping framework based on common genetic ancestors (haplogroups and SNPs) found in members' results, and added new members into this framework as they joined the project
- Interpreted members' autosomal DNA results, including Y haplogroups and match lists when available
- When possible, incorporated a member's genealogical information into the broader historical and genealogical context of the clan
- Encouraged MacLeods to take new Y-DNA tests, upgrade their older test results, and join the MacLeod surname project
- Communicated with members about their test results, and the MacLeod clan and the public about the high-level findings of the project

We continue these activities in our role as the current MacLeod surname project administrators.

### Selecting the most relevant Y-DNA test results

This study began when the MacLeod surname project had grown to 641 members. To map the genetic landscape of the MacLeod clan using the most relevant Y-DNA results, we first identified a subset of project members and test results from this large and highly varied project dataset.

DNA testing technology has advanced considerably during the MacLeod project's 20-year history and, as a result, project members have taken a wide variety of DNA tests. The most definitive Y-DNA test today, called Big Y-700, was taken by 234 members, while 282 members tested below the Big Y level, with tests ranging from 12 to 111 Y-STR markers (Fig. 1). Finally, 364 members took FTDNA's Family Finder autosomal DNA test or uploaded their results from another testing company.

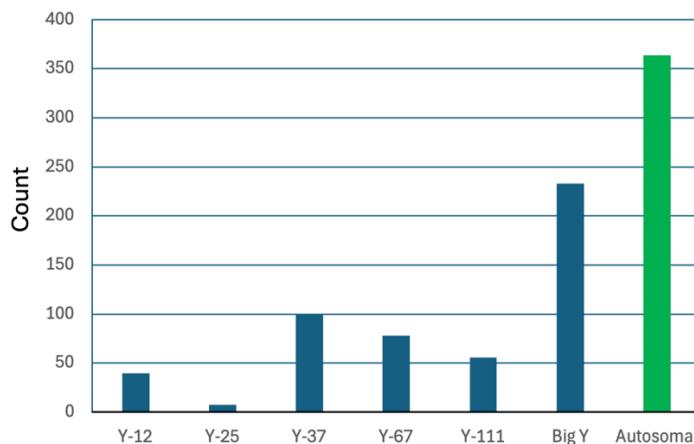


Figure 1. Test counts showing maximum Y-DNA testing level and autosomal tests for members of the MacLeod DNA Project.

As with many of the surname projects at FTDNA, the MacLeod project grew to include many members whose DNA results were not relevant to a focused Y-DNA study of the MacLeod clan. After careful review, the following project members were excluded from this study:

- 143 members whose Y-DNA results indicated no obvious connection to the MacLeod genetic subgrouping framework. Many of these members tested below Big Y, and their haplogroup designations were not definitive enough for this study. 85 of these members were deemed ‘Visitors’ with no genetic or surname connection to the MacLeods.
- 121 members who had not taken a Y-DNA test.
- 19 members who indicated only maternal links to the MacLeod clan.

We also excluded from this study the Y-DNA results from 11 MacLeods in three distinct MacLeod clan haplogroups, namely E, I2/I-P15, and R-FTT1, given the small number of members in these subgroups.

The Y-DNA results of 17 members from Norway, Orkney, and the McNeill clan were used to inform our study into the origins of Clan MacLeod (discussed below), but they were not included in the subgrouping framework.

Finally, once the remaining members were placed in the genetic subgrouping framework, we excluded a further 45 members who did not carry the MacLeod surname *or* did not indicate an earliest known ancestor with the MacLeod surname. Thirty of these excluded members were very distantly linked to MacLeods in one of the four ‘non-founder’ subgroups listed in Table 1 below. Therefore, their paternal lines do not lead to the chiefly line of MacLeod. The fifteen other excluded members (with 11 different surnames) each had at least 40 Y-111 matches to other members with the MacLeod surname and they shared recent SNPs with these ‘chiefly line’ MacLeods. This supports our view that an NPE or adoption may have occurred somewhere in these members’ paternal lines and that their distant ancestors are MacLeods.

After these exclusions, we were left with **280** MacLeod-surnamed members who had taken some level of Y-DNA test. Of these, 139 had taken the Big Y test, 135 had taken an autosomal DNA test and 91 had taken both tests.

## Examining Y-DNA SNPs, match lists and STRs

The MacLeod genetic subgrouping framework was developed and refined by project administrators over the years to cluster genetically similar MacLeods based on their Y-DNA haplogroups. These haplogroups varied considerably in date of formation and were typically influenced by the members' level of Y-DNA test. More recent haplogroups were often found using the Big Y DNA test. We used FTDNA's average age estimates and ranges for all haplogroups and SNPs in this study.

When the test level was below Big Y, we used Y-DNA match lists above Y-25 markers, unique patterns in STR allele values, and known family connections to guide placement in subgroups. For example, if a MacLeod tested only to Y-67 markers with a haplogroup designation of R-M269 (born circa [b.c.] 4400 BCE) and he matched many Big Y-tested MacLeods with the SNP BY3210 (b.c. 900 CE), we added this member to the BY3210 subgroup. Results from MacLeods with maximum test levels of Y-12 and Y-25 were generally excluded from this study, as the match results were often unreliable.

We reviewed the Y-DNA match lists of all members of each subgroup, focusing on the Y-111 marker level. We searched for and counted each member's MacLeod-surnamed matches to determine how closely they were related to other MacLeods. Finally, we computed the average number of MacLeod-surnamed matches at Y-111 markers for each subgroup.

We also took note if there was a frequently repeated surname in the member's Y-DNA match list that was different than MacLeod, which might indicate adoption or misattributed parentage somewhere in the member's paternal line.

## Finding the distant origins of the MacLeod genetic subgroups

The SNP Tracker tool from Scaled Innovation provided possible migration pathways of the distant ancestors of members in all genetic subgroups ([www.scaledinnovation.com](http://www.scaledinnovation.com)).

## Evaluating autosomal DNA results

When a MacLeod in this study had also taken an autosomal DNA test, we searched their autosomal DNA match list for any MacLeod matches with an assigned paternal haplogroup. The goal was to determine whether MacLeods in one subgroup are related to MacLeods in other subgroups. We then noted the match level in centimorgans (cM) and counted the number of matches to MacLeods who were in the 'founder' genetic Subgroup 5, described below.

## Results

### Y-DNA genetic subgrouping framework

We placed the 280 members of the MacLeod project into one of five high-level Y-DNA genetic subgroups (Table 1). Each subgroup was defined by the most recent SNP that is common to all members in the subgroup. There was no single common ancestor (i.e., SNP) born in the Common Era (CE) for all MacLeods in the study, and only Subgroup 5, the largest subgroup, had a common ancestor born in the Common Era.

A	B	C	D	E	F	G	H	I	J	K
Sub-group #	Old main branch name	High-level Y-DNA haplogroup & ancestral path leading to most recent shared SNP in subgroup	Mean age of most recent shared SNP	Number of MacLeod-surnamed members	Number of MacLeod Big Y tests	Number of MacLeod atDNA tests	Avg number of MacLeod-surnamed matches at Y-111, Big Y tests	Number of atDNA matches to BY3210 MacLeods	Origins before Scotland	Possible cultural origins of ancestors
1	R1b	R-M343 >> U106 > BY30097	2848 BCE	15	8	10	2.8	30	Scandinavia	Vikings
2	R1a	R-M420 >> Z284	2170 BCE	33	16	17	1.9	79	S. Norway	Vikings
3	I1a	I-M253 > DF29	2423 BCE	40	21	18	3	73	S. Norway	Vikings
4	R1b	R-M343 >> L21 >> DF13	2481 BCE	49	20	28	0.3	93	Eng./Ireland	Celts
5	R1b	R-M343 >> BY3210	900 CE	143	74	62	45	NA	Orkney	Vikings
		<b>Totals</b>	<b>280</b>	<b>139</b>	<b>135</b>					

Table 1. The five main Y-DNA genetic subgroups of Clan MacLeod. Each subgroup was defined by the most recent SNP that is common to all members in the subgroup. The table is sorted by the number of MacLeods in each subgroup. The subgroup color in Column A is used on the publicly available MacLeod surname project DNA Results page: <https://www.familytreedna.com/groups/acms-mac-leod/dna-results>. This site provides the complete and more detailed MacLeod Y-DNA genetic subgrouping framework.

## Overview of the five main Y-DNA genetic subgroups of Clan MacLeod

In this section, we review the five main genetic subgroups of the MacLeod clan, focusing on the recent origins and most recent common ancestors of the subgroup members, their Y-DNA match lists, and the very distant origins of their ancestors.

### Subgroup 1: R-M343 >> U106 > BY30097

With only 15 members, Subgroup 1 is the smallest of the five main subgroups in the MacLeod project. The most recent common ancestor of the eight Big Y-tested members of this subgroup is BY30097. This SNP has an average estimated birth year of 2848 BCE, which emerged just after U106 (b.c. 2900 BCE).

That said, five of the eight Big Y-tested MacLeods in this subgroup were found to share a more recent common ancestor, namely BY62045. This SNP represents a man born circa 1330 CE, likely in Scotland, which shows that the use of the MacLeod surname goes back centuries (Fig. 2).

These five MacLeods have many Y-67 matches with testers from Scotland, Finland, Norway and Sweden. Two of these members indicated that their earliest known paternal ancestor (EKA) was from Caithness in northern Scotland.

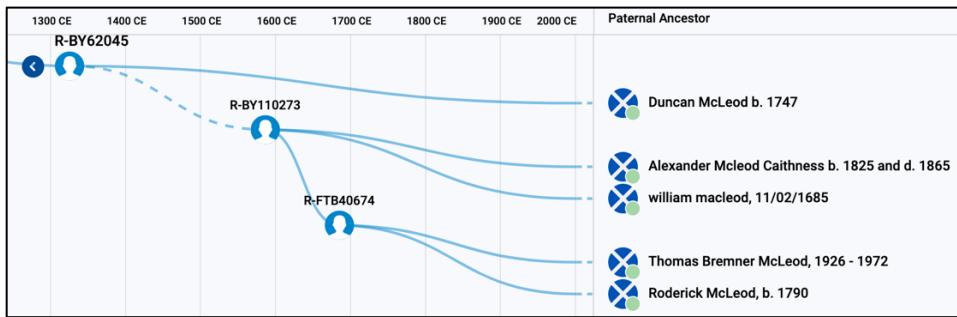


Figure 2. Time Tree display for five of the eight Big Y-tested U106 MacLeods demonstrating a common ancestor BY62045 who was born around the time of the start of Clan MacLeod. Two of these MacLeods list EKAs from Caithness in northern Scotland. *From FTDNA.*

U106 MacLeods have few MacLeod-surnamed Y-DNA matches. At Y-111 markers, the Big-Y tested members had an average of 2.8 MacLeod-surnamed matches (Table 1, column H). As expected, their only MacLeod matches were with their genetic cousins, namely other U106 MacLeods.

The SNP Tracker shows that distant ancestors of FTD91242 (b.c. 1570 CE), a SNP carried by two U106 MacLeods, likely came from Northern Europe, whereas the ancestors of BY62045 likely came from Scandinavia, probably during the Viking era (Fig. 3).

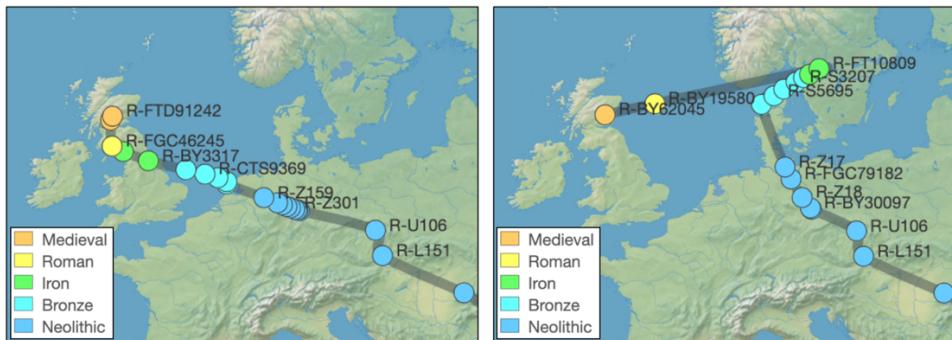


Figure 3. Possible migration pathways to Scotland for U106 MacLeods in Subgroup 1, from Central Europe through Northern Europe or via Sweden. *From scaledinnovation.com.*

## Subgroup 2: R-M420 >> Z284

The common ancestor for the 16 Big-Y tested MacLeods in this subgroup is Z284, a man born circa 2170 BCE. As with Subgroup 1, there are several branches with members who share a more recent common ancestor. For example, six of these 16 Big Y-tested MacLeods (and one Beaton) share a common ancestor BY73140, a man born circa 1130 CE (Fig. 4). Several of these MacLeods indicated an earliest known paternal ancestor from the Isle of Lewis. Once again, this chart demonstrates that the MacLeod surname has been in use for centuries.

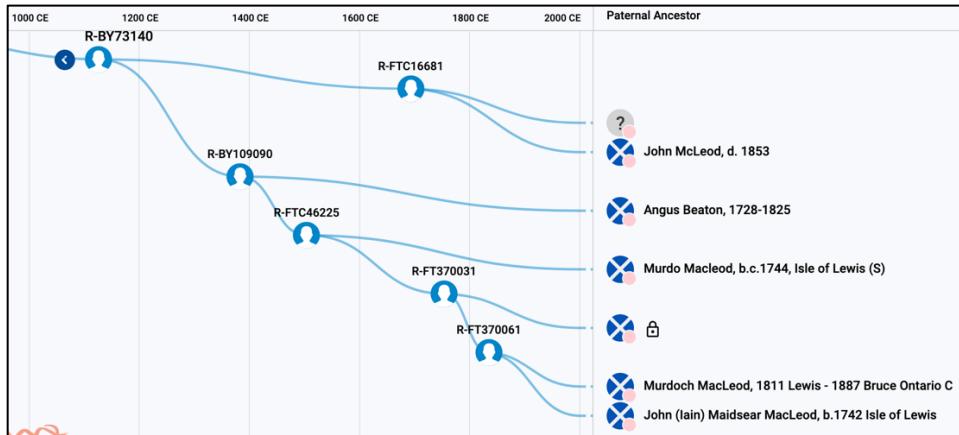


Figure 4. Time Tree display for six of the 16 Big Y-tested Z284 MacLeods in Subgroup 2 demonstrating a common ancestor BY73140 who was born around the time of the start of Clan MacLeod. Many of these MacLeods list EKAs from the Isle of Lewis. *From FTDNA.*

As with Subgroup 1, Z284 MacLeods had very few MacLeod-surnamed Y-DNA matches, reflecting the small subgroup size and significant genetic diversity within this subgroup (Table 1, column H). Furthermore, most Y-DNA matches at Y-111 and Y-67 markers showed EKAs from Scotland, with a few from Norway.

Three MacLeods in this subgroup have many matches who carry the MacAskill surname. One traced his paternal line to an illegitimate son of Margaret MacLeod (1685-1735), daughter of Sir Norman MacLeod of Berneray (MacLeod, 2023). The historical record lists Neil Beaton as the father, but the Y-DNA results suggest the father was actually a MacAskill.

The SNP Tracker shows that this line likely arrived in Scotland from southern Norway, probably during the Viking era (Fig. 5). This track is similar for all Z284 MacLeods in Subgroup 2.

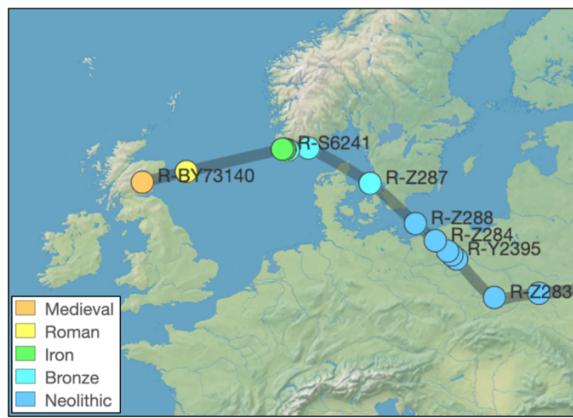


Figure 5. Possible migration pathway from southern Norway to Scotland for a subset of Z284 MacLeods in Subgroup 2. *From scaledinnovation.com.*

### **Subgroup 3: I-M253 > DF29**

This subgroup is the only significant 'I' branch of MacLeods; the other four main subgroups are linked to parts of the 'R' branch that split from the 'I' branch over 40,000 years ago. DF29 was born circa 2423 BCE and today there are over 4500 men from Sweden who carry this SNP, reflecting the likely origins of DF29.

Like the two previous subgroups, most members of this subgroup had few MacLeod-surnamed Y-DNA matches, a result of the small subgroup size and significant genetic diversity within this subgroup (Table 1, column H). A few DF29 MacLeods have Y-DNA matches from Scandinavian countries, but most show matches with EKAs from Scotland.

However, within the DF29 subgroup, there were seven Big Y-tested members with EKAs from the Isle of Raasay in Scotland (Fig. 6). Another MacLeod with Raasay ancestry tested only to Y-37 but carries a uniquely identical pattern of STR allele values, showing that he is also part of this subgroup. Their common ancestor is I-FT381308, a man born circa 1593 CE.

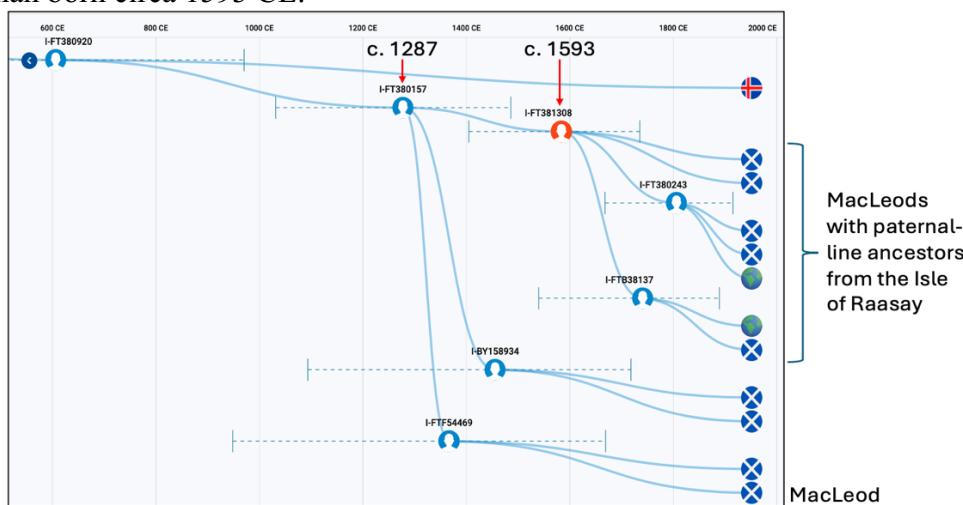


Figure 6. Time Tree display for seven of the 21 Big Y-tested DF29 MacLeods who share a common ancestor born circa 1593, possibly on Raasay. The man at the top of the chart could be a descendant of the Vikings who settled Iceland. *From FTDNA.*

The SNP Tracker shows that the distant ancestors of this Raasay subgroup may have arrived in Scotland from southern Norway, possibly during the Viking era (Fig. 7). This track is similar for all DF29 MacLeods, which shows that all members of this subgroup have similar origins.

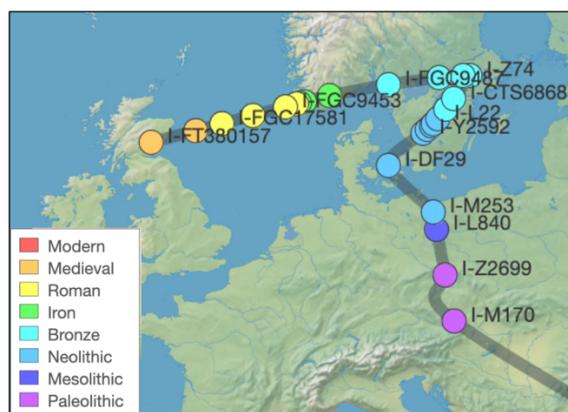


Figure 7. Possible migration pathway from southern Norway to Scotland for a subset of DF29 MacLeods in Subgroup 3. *From scaledinnovation.com.*

## Subgroup 4: R-M343 >> L21 >> DF13

This subgroup of MacLeods is the most genetically diverse in the project. The most recent common ancestor (MRCA) for all Big Y-tested MacLeods in this subgroup is DF13, a man born circa 2484 BCE, soon after L21. Unlike Subgroups 1-3, there is no branch with more than two MacLeods who share an MRCA in the Common Era. Evidence for the genetic diversity of this subgroup is found in the very low average number of MacLeod-surnamed Y-DNA matches at Y-111 markers (Table 1, column H).

Many members in this subgroup have Y-DNA matches with paternal ancestors from Ireland, Scotland and England. In the FTDNA database, there are over 10,000 testers with the DF13 SNP who have origins in Ireland. This is consistent with the widely held view that the L21 SNP has Celtic origins (Wikipedia, Haplogroup R-L21).

Most DF13 MacLeods have no common surnames in their Y-DNA match lists. An exception is five MacLeods who have match lists dominated by the Nicolson surname. All five have well-documented MacLeod genealogies going back to around 1800 CE. The three Big Y-tested members share the SNP FTB33021 (b.c. 1700 CE) with several Nicolsons whose paternal line leads to the chiefly line of Nicolsons from Scorrybreac, Skye.

DF13 MacLeods typically show migration pathways passing through England and Ireland before arriving in Scotland (Fig. 8).

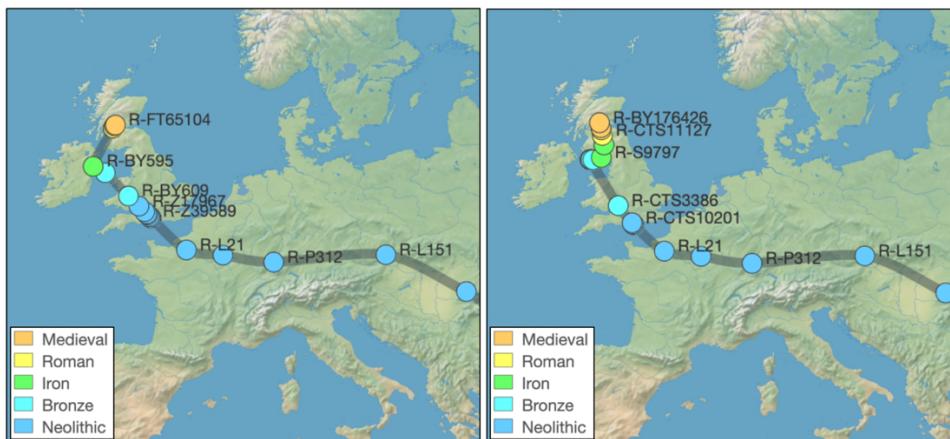


Figure 8. Possible migration pathways of two DF13 MacLeods from France into England before arriving in Scotland. *From scaledinnovation.com*.

Based on the SNP Tracker display, some of the DF13 descendants were settled in Scotland before the arrival of the Vikings and the start of Clan MacLeod. Some became part of the MacLeod clan and assumed the surname.

## Subgroup 5: R-M343 >> BY3210

The BY3210 subgroup is by far the largest subgroup in the project. Compared to the previous subgroups, BY3210 first appeared in a man born relatively recently (c. 900 CE) and, together with the large number of MacLeods who share this SNP, members of this subgroup have far more MacLeod Y-DNA matches than the

four prior subgroups (Table 1, column H). Furthermore, there are 52 branches below BY3210, making it one of the better studied surnames at FTDNA.

Two recently discovered SNPs descending from BY3210 align with the traditionally established branches of the MacLeod clan. BY3210 MacLeods who carry the SNP **FTT137** commonly indicated links to ancestors from the traditional lands of the Harris & Dunvegan branch of MacLeods, while those who carry **FTT138** commonly associated their heritage with the Isles of Lewis & Raasay. More specifically, 12 MacLeods who tested positive for the SNP FTT137 indicated earliest known ancestors (EKAs) born on lands typically associated with the Harris & Dunvegan branch whereas only one FTT137-positive MacLeod indicated an EKA born on the Isle of Lewis. Conversely, 36 MacLeods who tested positive for the SNP FTT138 indicated EKAs born on lands typically associated with the Lewis and Raasay branch, while five FTT138-positive MacLeods indicated EKAs from Skye. We used Fisher's exact test and found that there was a significant association between the SNP and the branch name ( $p < .001$ ) (<https://www.technologynetworks.com/tn/articles/the-fishers-exact-test-385738>)

In addition, there is a clear difference in the number of repeats at marker DYS389i between members who carry these two SNPs: 95% of those who carry FTT137 have **14** repeats at marker DYS389i, while 92% of those who carry FTT138 have **13** repeats at the same marker. This serves as a useful 'genealogical hint' for those without a Big Y test. For example, consider a MacLeod who tested only to Y-67 markers and had many Y-DNA matches with BY3210 MacLeods. If the number of repeats at marker DYS389i was **13**, his pedigree was likely on the Lewis & Raasay branch.

Based on the observation that Big Y-tested BY3210 MacLeods match many other BY3210 MacLeods, we added 60 MacLeods to this subgroup who had tested at levels below Big Y even though their predicted or confirmed haplogroup was much older than BY3210. These 60 men match many BY3210 MacLeods, and their allele values also conform to typical BY3210 STR allele values.

The origins of Subgroup 5 are discussed below.

## Autosomal DNA results

In our review of autosomal DNA test results, we found that MacLeods in all five genetic subgroups described above *invariably* had autosomal DNA matches to MacLeods in at least one other subgroup. For example, six of the ten U106 MacLeods with an autosomal test in Subgroup 1 match BY3210 MacLeods in Subgroup 5.

Overall, 75% of MacLeods in Subgroups 1-4 are autosomal DNA matches to at least one BY3210 MacLeod in Subgroup 5. There were 275 unique autosomal DNA matches between MacLeods in Subgroups 1-4 and BY3210 MacLeods in Subgroup 5, with an average match value of 20 cM (std dev: 14.8, median: 15, range: 8-101 cM) (Table 1, column I).

In short, most MacLeods in the project were, in one way or another, related to each other. The low match levels imply distant common ancestry.

## Discussion

These results raise five important questions that are addressed below:

1. What is the evidence that the BY3210 MacLeods descend from Leòd?
2. If MacLeods in Subgroup 5 are the paternal-line descendants of Leòd, why do MacLeods in other subgroups carry the MacLeod surname?
3. Why do MacLeods have autosomal DNA matches to MacLeods in other subgroups?
4. Can SNPs descending from BY3210 be linked to individuals in a chiefly line of Clan MacLeod?
5. What are the origins of the BY3210 MacLeods?

## **1. What is the evidence that the BY3210 MacLeods descend from Leòd?**

The main evidence that BY3210 MacLeods are paternal-line descendants of Leòd is as follows:

- Subgroup 5 is by far the largest subgroup of related MacLeods in the project, and the estimated age of their shared SNP BY3210 is near the time of the traditional founding of the clan. No other subgroup comes near this number of closely related MacLeods with an MRCA in the Common Era.
- Several testers with the BY3210 mutation have paternal lines leading to the chiefly line of one of the two main branches. Key examples are: 1) Three MacLeods descending from the Drynoch, Talisker, and Glendale cadet branches of the Harris & Dunvegan branch, and 2) Two MacLeods who are close relatives of the current Raasay clan chief (discussed below) on the Lewis & Raasay branch. We are unaware of any member in the other four subgroups who has a pedigree leading to a chiefly line of MacLeod.
- The SNPs FTT137 and FTT138 match the traditional split of the clan into two main branches. No other subgroup shows this genetic and geographical split linked to the two main MacLeod branches. As discussed above, members with well-established pedigrees tend to carry the SNP associated with their branch.

## **2. If MacLeods in Subgroup 5 are the paternal-line descendants of Leòd, why do MacLeods in other subgroups carry the MacLeod surname?**

MacLeods in Subgroups 1-4 comprise about half of all the MacLeods in this study. If BY3210 represents the top of the chiefly lines, MacLeods in Subgroups 1-4 may descend from people who assumed the MacLeod surname many centuries ago. This was common practice in Scottish clans, per ScotlandsPeople:

*It is a common misconception that those who bear a clan surname are automatically descended from a clan chief. The ability of a clan to defend its territory from other clans depended greatly on attracting as many followers as possible. Being a member of a large and powerful clan became a distinct advantage in the lawless Highlands and followers might adopt the clan name to curry favour with the Laird, to show solidarity, for basic protection, or because their lands were taken by a more powerful neighbour, and they had little option! Yet others joined a clan on the promise of much-needed sustenance.*

*Crown copyright, <https://www.scotlandspeople.gov.uk/help-and-support/guides/surnames#Scotland>*

The Time Tree displays for Subgroups 1-3 show that the MacLeod surname has been used for centuries (Figs. 2, 4, and 6) and we expect the same is true for Subgroup 4. These MacLeods have been part of the clan since it began. However, it seems unlikely that men in these 4 subgroups were part of cohesive ‘clans’ during the

Middle Ages given that they did not share a known common ancestor. It's more likely that men within Subgroups 1-4 acted independently when they assumed the MacLeod surname while living amongst MacLeods from Subgroup 5.

Genetic diversity is typical of other clan-related surname projects at FTDNA including Clans Donald, MacKenzie, Grant, Mackay and Cameron. While one group of testers has Y-DNA results suggesting descent from the progenitor of the clan, other testers are genetically different and likely descend from people who assumed the clan surname.

### **3. Why do MacLeods have autosomal DNA matches to MacLeods in other subgroups?**

Autosomal DNA matches between members in two different Y-DNA subgroups (e.g., Subgroups 1 and 2) cannot have common ancestors along their respective paternal lines because these lines do not intersect within the last five thousand years. Instead, these matches point to more recent common ancestors in other parts of their family trees. Many if not most of these common ancestors are likely MacLeods, although it is certainly possible that two matching MacLeods may share a common ancestor with a different surname.

The autosomal DNA matches between MacLeods in different subgroups imply intermarriage between subgroups, which likely existed since the start of the clan. Census and other records show that the MacLeod surname was very common in the Highlands and northwest Scotland in the 1800s. MacLeod family trees often show MacLeods on more than one line if the tree extends far enough back in time.

The small islands of Raasay and nearby Rona, just east of Skye, offer a relevant case study. Twenty-eight MacLeods in this study have paternal lines leading to ancestors from Raasay. Twenty of these are in Subgroup 5, on the Lewis & Raasay branch (FTT138), while eight are in Subgroup 3 (see Fig. 6). All eight have autosomal DNA matches to Subgroup 5 MacLeods from Raasay.

In the 1841 census on Raasay and Rona, MacLeod was by far the most common surname, with about 35% of the population born a MacLeod. Given the high concentration of MacLeods, it was practically impossible for a MacLeod to marry someone who was *not* somehow related to another MacLeod. In fact, MacLeods often married other MacLeods. A search in ScotlandsPeople shows that from 1855-1900 there were 11724 marriages in Scotland that included at least one MacLeod, and 10% of these were between two MacLeods. On Raasay, 17% of MacLeod marriages were between two MacLeods. The indigenous people of Raasay have many MacLeods in their family tree on both their paternal and maternal sides and they are commonly related to one another in several ways. In the 1800s, Raasay was an endogamous society with limited influx of unrelated people. This has led to common ancestors appearing in multiple places in a Raasay person's family tree.

The pedigree view of the family tree of a man born on Raasay shows the high MacLeod concentration and degree of intermarriage between MacLeods (Fig. 9). In this tree, each person who was born a MacLeod is highlighted in red. His sixteen great-great-grandparents were born on the Isle of Raasay or nearby Rona, and nine are MacLeods.

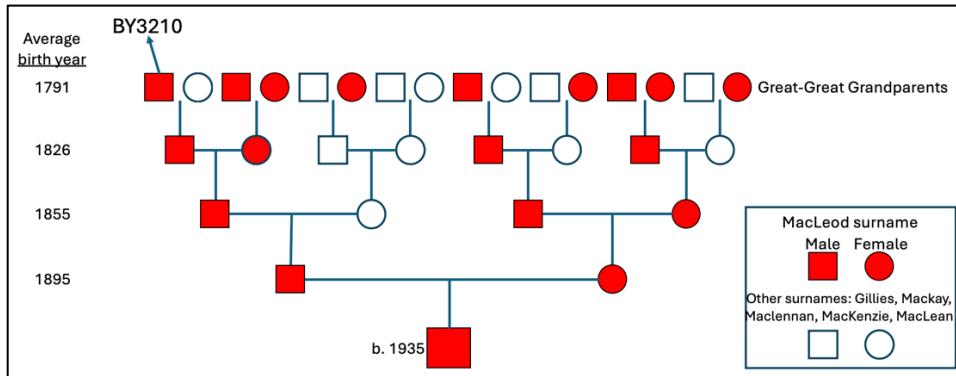


Figure 9. Pedigree view of a family tree of a man born on Raasay. Symbols in red indicate a person born with the MacLeod surname. This BY3210 MacLeod is an autosomal DNA match to many MacLeods in Subgroups 1-5.

This man is an autosomal DNA match to MacLeods in all five genetic subgroups. He carries the BY3210 SNP (Subgroup 5, subclade BY19719) which he inherited along his paternal line, but we do not know the genetic details of some of the other MacLeods in his tree. Given the autosomal match results, there are MacLeods from Subgroups 1-4 somewhere in his tree.

These results paint a very interesting picture of the early MacLeod clan. Ancestors of four of the five MacLeod subgroups likely came from different parts of Scandinavia during the Viking era (ca. 800-1050 CE) and settled in western Scotland. The one non-Viking group (Subgroup 4) may have already been living in the area before the Vikings arrived. The MacLeod clan began in the 1200s and autosomal DNA shows that the descendants of the founder intermarried with members of all other groups who had assumed the MacLeod surname and became part of the clan.

Therefore, a MacLeod in Subgroup 1-4 who is an autosomal DNA match to a BY3210 MacLeod can claim a genetic link to the founder of the clan – not along their paternal line but somewhere in their tree through a maternal connection.

These autosomal DNA results also provide a cautionary tale for those trying to find common ancestors given an autosomal DNA match to another MacLeod or person with Scottish heritage. With the prevalence of intermarriage that has lasted for centuries, many of these autosomal DNA matches will be impossible to connect to common ancestors in the Modern Era.

#### 4. Can SNPs descending from BY3210 be linked to individuals in a chiefly line of Clan MacLeod?

The first appearance of a Y-DNA SNP is unique to one man, so it is theoretically possible to match a SNP with a named ancestor, assuming the relevant ancestor's name is known. This is relatively easy for very recent SNPs with well-known paternal ancestry, but it becomes far less certain for older SNPs. To assign early MacLeod SNPs to individuals in the chiefly lines, we are guided by 1) the genealogy of the chiefly lines of MacLeod; 2) the genealogy and oral tradition of some of our members; and 3) FTDNA's average age and range estimates for the SNP. All these pieces of information carry uncertainty and possible errors, including confirmation bias, which makes assigning SNPs to names a speculative exercise.

According to the standard account, the chiefly line of MacLeod started with Leòd, b.c. 1215 CE (Fig. 10). His son Norman became the second chief. Norman's first son Malcolm became the third of a long line of chiefs on a branch now known as the MacLeods of Harris & Dunvegan. Norman's second son Murdoch had a son named Torcall Òg (b.c. 1320), who is viewed as the first of a branch known as the MacLeods of Lewis and Raasay. At some point in time (discussed below), the chiefly line of the MacLeods of Raasay branched off from the line of Lewis MacLeod chiefs. These main branches were distinct, independent, and had very different histories.

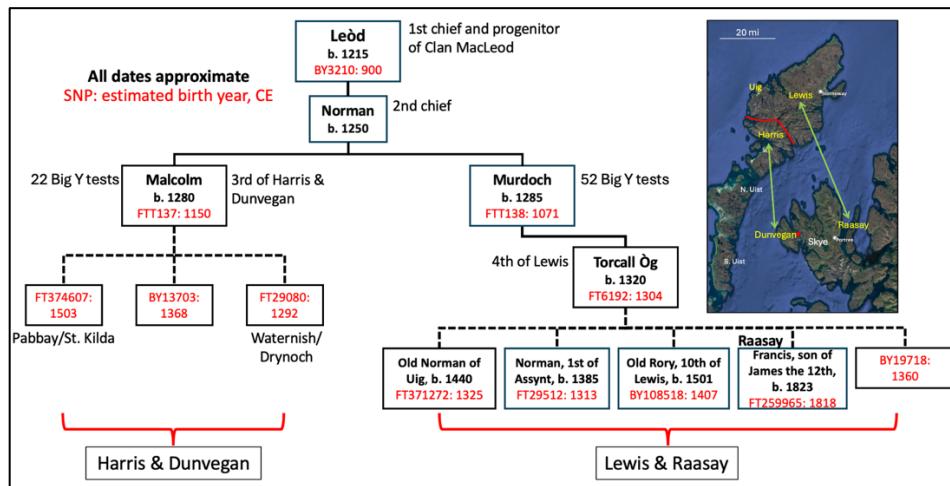


Figure 10. The chiefly lines of MacLeod with speculative links to SNPs found in 74 Big Y-tested MacLeods in Subgroup 5. The greater definition on the Lewis & Raasay branch is due in part to the greater number of Big Y tests; 27 descendant branches are not shown. On the Harris & Dunvegan branch, 14 descendant branches are not shown.

The SNP BY3210 aligns with the start of the chiefly line of MacLeod, so it is reasonable to assign BY3210 to Leòd. It's also possible that BY3210 first appeared in one of Leòd's paternal ancestors.

As mentioned above, the SNPs FTT137 and FTT138 are mutually exclusive and are carried by MacLeods who have pedigrees associated with either the Harris & Dunvegan branch or the Lewis & Raasay branch. Therefore, we speculatively assigned FTT137 to Malcolm, the 3<sup>rd</sup> chief, and FTT138 to his brother Murdoch. While unusual, it is not impossible for each brother to have been born with his own unique SNP.

Additional proposed SNP-to-name assignments on the Lewis & Raasay branch are:

- FT6192 to Torcall Òg, b.c. 1320, based on the close fit of the respective birth years for the SNP and Torcall Òg. Torcall Òg also had many male descendants.
- FT371272 to Clann Thormoid, specifically Old Norman of Uig, Lewis, b.c. 1440. This is based partly on a member who claims descent from Iain mac Thorcaill (b.c. 1650) of Hacklete, in western Lewis. Morrison links Iain mac Thorcaill to Old Norman, who was a brother of Roderick, the 7th chief (Morrison, 1999, pg. 15). Several descendants of FT371272 have traced their ancestry to Uig, Lewis.
- FT29512 to Norman, 1<sup>st</sup> of Assynt, b.c. 1385, based partly on four members in this haplogroup whose ancestry is from the Assynt region (Adolph, 2009). Norman of Assynt was a brother of Torquil, the 6<sup>th</sup> of Lewis.

- BY108518 to 'Old Rory', 10<sup>th</sup> of Lewis, b.c. 1501, based partly on a member whose grandfather told the poet Sorley MacLean that he was a descendant of Torquil Dubh, son of Old Rory (MacLean, 1976).

## Why not test the current clan chiefs?

The patrilineal descent of MacLeod chiefs of Harris & Dunvegan ended when Sir Reginald MacLeod, 27<sup>th</sup> chief, died in 1935 without leaving a male heir. The current chief, Hugh MacLeod is a descendant of Dame Flora MacLeod, 28<sup>th</sup> chief. Therefore, there is no living chief who is a patrilineal descendant of Leòd in the Dunvegan branch who could usefully take a Y-DNA test.

On the Lewis & Raasay branch, the last chief of the MacLeods of Lewis in the era was Old Rory, 10<sup>th</sup> of Lewis, who died in 1595. Old Rory was a patrilineal descendant of Torcall Òg. However, the unbroken male line of Raasay clan chiefs continues to this day with John Macleod, 18th of Raasay. Fortunately, a 2<sup>nd</sup> and 3<sup>rd</sup> cousin of Chief John have taken Big Y tests. As expected, both carry the SNPs BY3210, FTT138, and FT6192, indicating descent from Leòd and then Torcall Òg on the Lewis & Raasay branch. Their MRCA is Francis Hector George Macleod, born in 1823 and son of James Macleod, 12<sup>th</sup> of Raasay (Morrison, 1999, pp. 73-74). After FT6192, their next SNP is **FT259965** with an estimated birth year of 1818 which we can confidently assign to their most recent common ancestor Francis.

**FT259965** is just one of five equivalent SNPs, representing a time span approaching 500 years. This closely matches the time span between the births of Torcall Òg (FT6192) and Francis Hector George Macleod (FT259965). Furthermore, these five equivalent SNPs are unique to these two Big Y tests and therefore unique to the Raasay chiefly line; they are not shared by the 50 other Big Y-tested MacLeods descending from Torcall Òg.

## Genetic genealogy of the MacLeods of Raasay

Many authors claim that the 1<sup>st</sup> chief of the MacLeods of Raasay – Malcolm Garbh – was a son of Malcolm, 9<sup>th</sup> of Lewis, and younger brother of Old Rory, 10<sup>th</sup> of Lewis (e.g., MacKenzie, 1889, pg. 344, Morrison, 1999, pg. 39). The two Big Y results discussed above cast some doubt on Malcolm Garbh's paternal ancestors. The most recent common *genetic* ancestor of the Raasay chiefly line and the Lewis chiefly lines mentioned above is FT6192, who we have assigned to Torcall Òg. This suggests that the Raasay chiefly line branched off much earlier than claimed.

In support of this suggestion, these two Big Y results are not inconsistent with the Raasay genealogy proposed by Norma MacLeod (2002). In her work, the chiefly line of Raasay descends from Calum Beag nam Buadhan, a son of Torcall Òg, and the line leads through the MacLeods of Gairloch.

## Age mismatch between SNPs and birth years

There is an obvious mismatch with the estimated age of some SNPs, including BY3210, FTT137 and FTT138, and the birth year of the linked individuals in the chiefly line. For example, the current estimated age of BY3210 is 900 CE with a 95% confidence interval of 656 – 1105 CE. This clearly does not fit Leòd's estimated birth year of 1215 CE. One possible explanation is that FTDNA's age estimation algorithm was negatively impacted by the 2750-year time gap and the 45 equivalent variants between ancestral SNPs BY19719 and BY3253 (Paul Maier, FTDNA, personal communication, 2024).

## 5. What are the origins of the BY3210 MacLeods?

The long-standing tradition is that Leòd and the MacLeod clan are of Norse descent. While several historians and genealogists have disagreed on important details about the progenitor and his ancestors, most have agreed that Leòd's origins are in Norway (e.g., Matheson, 1977, Morrison, 1986, Sellar, 1998, MacLeod, 2000). However, long ago, W. F. Skene (1886) maintained that the MacLeods were Celtic in origin, and Wilson (2023) recently suggested that the MacLeod clan may descend from Scottish Picts based on Y-DNA testing.

The SNP Tracker display for BY3210 (Fig. 11, A) shows that the very distant ancestors of BY3210 MacLeods were possibly living in what is now France in the Neolithic Age (e.g., SNP BY19719, b.c. 2100 BCE). The next position on the migration path is the green dot labeled BY3253 (b.c. 650 CE) in Scotland, which does not fit the Norse origins tradition<sup>3</sup>. However, note that there is no light blue dot representing the Bronze Age, which lasted roughly 3000 years.

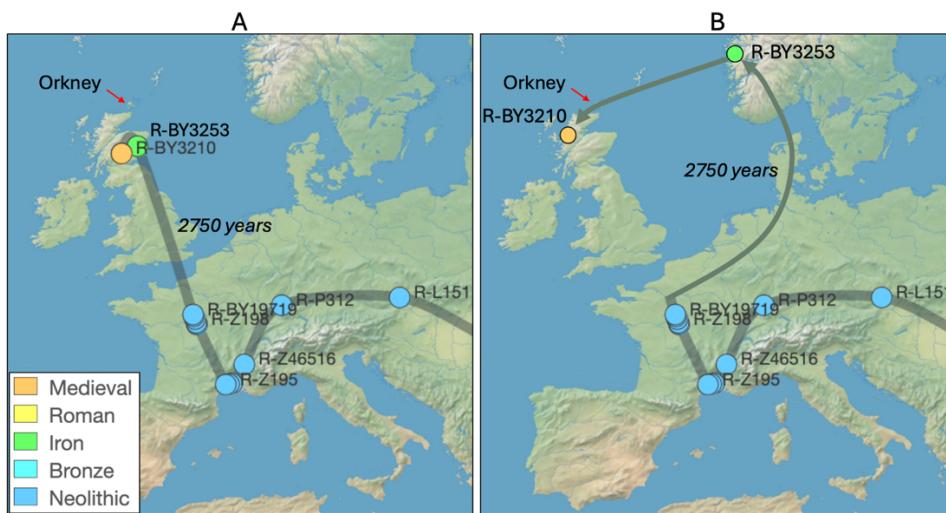


Figure 11. A) Possible migration path for the MacLeods who share the SNP BY3210. From scaledinnovation.com. B) Manually modified migration path after accounting for the bias introduced by the large number of BY3210 MacLeod test results.

Without further information, the SNP Tracker tool places SNPs on the map using the birth locations of the most common earliest known ancestors (EKAs) of the men who tested positive for these SNPs. In this case, 70 men who tested positive for BY3253 reported that their EKAs came from Scotland, and 10 reported that their EKAs came from Norway. Therefore, SNP Tracker placed the green BY3253 dot in Scotland. Of these 70 'Scottish' men, 66 are BY3210 MacLeods and four are McNeills with origins on Skye. Clearly, the 20-year focus on MacLeod Y-DNA testing has influenced the placement of the green dot. If the bias introduced by the large number of MacLeod Y-DNA tests was removed, the green BY3253 dot would be placed in Norway, as discussed in more detail below (Fig. 11, B).

<sup>3</sup> FTDNA's Globetrekker tool shows a similar path for BY3210 as Scaledinnovation's SNP Tracker tool.

The ancestral path of BY3210 MacLeods includes an older SNP called L165 (also called S68) that first appeared in a man b.c. 2400 BCE, possibly in the same area of France as BY19719 (Fig. 12). Moffat and Wilson (2011) called the presence of S68 in the Highlands, Orkney, Shetland, and Norway a ‘classic pattern for a Viking marker in Britain’. MacLeod and McLeod (2013a, 2013b) used this statement to support the clan’s Norse origins tradition, since many MacLeods carry this marker, including several with links to the chiefly line. Today, 887 men have tested positive for L165, and they specified that their earliest known ancestors came from 24 different countries. Clearly not all descendants of L165 became Vikings!

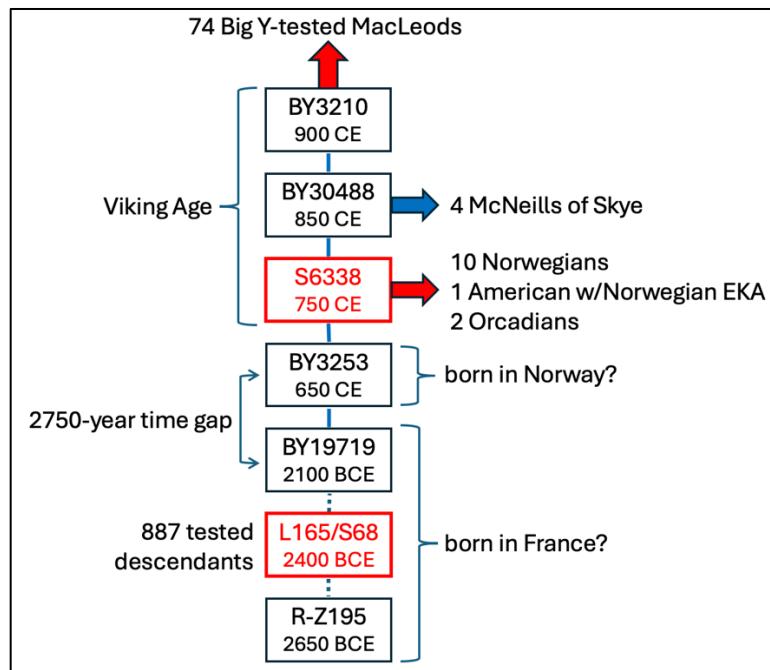


Figure 12. Ancestral path leading to BY3210 MacLeods highlighting SNPs L165 and S6338. Branching off from S6338 are 11 men with earliest known ancestors from Norway, supporting the Norse origins of the clan.

A more recent SNP that emerged just 250 years before the BY3210 MacLeods is S6338, b.c. 750 CE. Branching off from S6338 are 10 Y-DNA-tested Norwegians, and one American with a Norwegian EKA, most from the Ørsta municipality of Norway. There are also two key members from Orkney. They all have many Y-DNA matches to BY3210 MacLeods, indicating a close relationship.

These results suggest that during the 2750-year gap between BY19719 and BY3253, a branch of BY19719 migrated to Norway and the MacLeod clan’s distant ancestors originated in Norway during the Viking Age (c. 800-1050 CE).

Regarding the Norway/Orkney connection, an interesting pattern emerges when we look at the evolution of the allele value, i.e., the number of repeats for marker DYS449 (Fig. 13).

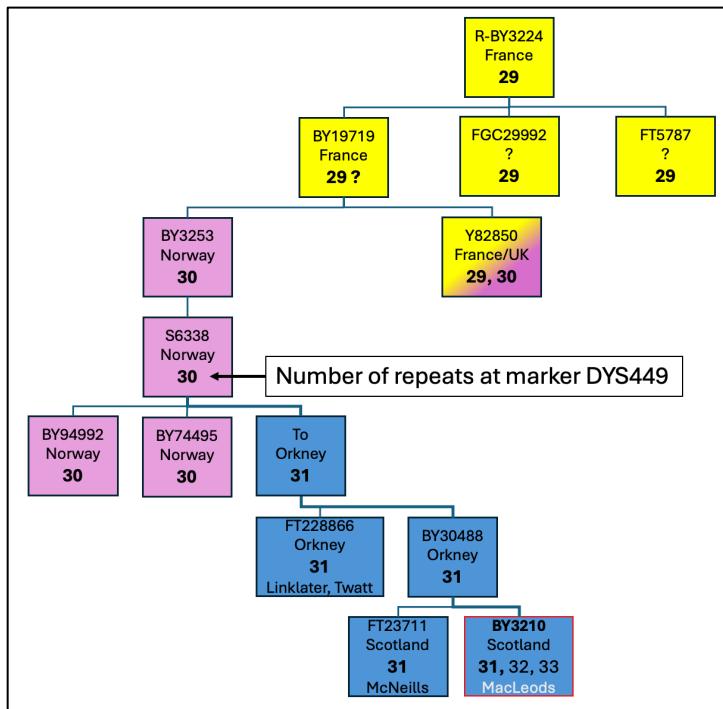


Figure 13. Evolution of the number of repeats for marker DYS449. This marker shows 29 repeats prior to the branch arriving in Norway (BY3253). The 11 members with Norwegian ancestry (branches BY94992 and BY74495) all carry 30 repeats. A branch of S6338 then migrated to Orkney with 31 repeats. Finally, the ancestors of the McNeills and BY3210 MacLeods arrive in Scotland, most carrying 31 repeats at marker DYS449.

STR mutations are certainly less stable than SNP mutations, but the allele values for DYS449 appear relatively stable, and the changes in the allele value over time tells a story. Before SNP BY19719, it appears that there were 29 repeats at marker DYS449. By the time the branch migrated to Norway (SNP BY3253), there were 30 repeats at this marker, as found in all 11 members with Norwegian ancestry. The two Orcadians (and two Americans with likely origins in Orkney) show that DYS449 now has 31 repeats. These Orcadians almost certainly descend from Norse Vikings who ruled Orkney from the 9<sup>th</sup> century until 1472. Finally, all McNeills and most BY3210 MacLeods also have 31 repeats, while a few have seen further mutations to 32 and 33 repeats.

These allele values show that before migrating to Scotland, Leòd's distant ancestors from Norway may have first settled in the Earldom of Orkney. This is consistent with genealogies proposed by Matheson (1997), Sellar (1998) and MacLeod (2000), where they show that Leòd's paternal ancestors may have carried the name Olvir, with roots in Orkney.

While the scenario described above is most likely, the Y-DNA results presented here have not *proven* that the distant ancestors of the MacLeods were not already in Scotland before arriving in Orkney and the Highlands. It is possible that ancestors of S6338 emerged first in Scotland as shown in Fig 11 A. If this was the case, descendants of these people would have then migrated east to Norway, perhaps taken by Vikings as slaves. Some of their descendants stayed in Norway (branches BY94992 and BY74495) while others migrated back west to Orkney and the Highlands (branches FT228866 and BY30488).

## Limitations and Future Work

This study included only 280 MacLeods, which is an extremely small non-random sample of the roughly 30,000 MacLeod men in the world today (<https://forebears.io/surnames/macleod>). While a large random sampling is perhaps unfeasible, more Y-DNA testing of MacLeods will increase our confidence in the results. Our hope is that we currently have at least a representative sample, given that the 280 MacLeods come from around the world, including Scotland, Australia, Canada and the US.

We recognize that there are more Big Y tests and genealogical detail on the Lewis & Raasay branch than the Harris & Dunvegan branch. Some of the former and current project administrators have ancestral roots on Lewis & Raasay which has led to Y-DNA testing and genealogical work targeted to that branch. More Big Y testing of Harris & Dunvegan MacLeods, including their territory on North Uist, coupled with genealogical work, could address this imbalance.

Future studies on DNA donated by those of a chiefly line or DNA obtained from ancient MacLeod graveyards (assuming the obvious ethical hurdles do not prove insurmountable) would add important new information to the study of the DNA of Clan MacLeod.

The MacLeod surname project administrators will continue to recruit new members and encourage current members to upgrade their Y-DNA tests to the Big Y level. As more MacLeods take the Big Y test, more sub-branches of BY3210 will be found. All the non-chiefly line subgroups will likely expand, more subgroups may be found, and their connections to the founder branch may become clearer. Confidence in the estimated age of each SNP will improve, and new age dating methods may be developed. We also hope to expand on and improve the links between MacLeod clan genealogy and Y-DNA results, particularly for the relatively under-sampled Harris & Dunvegan branch.

## Conclusions

Analysis of Y-DNA from 280 MacLeods has allowed us to paint a picture of the genetic diversity of the MacLeod clan. We found that most MacLeods can be placed into one of five genetically distinct subgroups. Four subgroups comprise MacLeods whose distant ancestors likely assumed the MacLeod surname centuries ago. The fifth subgroup includes MacLeods who carry the SNP BY3210 who we propose are descendants of Leòd, the founder of the clan. Two recently discovered SNPs descending from BY3210 coincide with the traditionally established split of the chiefly line into two main branches: the Harris & Dunvegan branch and the Lewis & Raasay branch.

Autosomal DNA results show that MacLeods whose ancestors assumed the surname intermarried with direct descendants of Leòd. Therefore, most living MacLeods will have a link to Leòd, whether directly along their patrilineal line or via a maternal connection.

Four of the five genetic subgroups have origins in different parts of Scandinavia, with Leòd's Norse ancestors possibly originating in Orkney, while the fifth group has Celtic origins. The MacLeod clan was and remains a melting pot of these diverse groups.

## Acknowledgements

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## Conflicts of Interest

The authors declare they have no conflicts of interest related to the results presented here.

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